Cambridge, and Dr. Charles Smallwood, of Montreal. Among other items, Mrs. Chickering notes that twice she has observed the rare forms of hexagonal plates and hexagonal axles or prisms joined together in various combinations, like wheels and axles. Some of her figures were copied while in a deliquescent state, and some of her forms would, she says, be probably rejected by science as being in a transition state, but, as she correctly remarks, even in their transitions they are as much under law as when fixed. Unfortunately the dates and general weather conditions are not fully given in this volume.

All preceding work was done with the hand, aided by the microscope, but Professor Hellmann reproduces the microphotographs taken by Dr. Neuhauss at Berlin, in 1892–3, at the request of Dr. Hellmann. These pictures show the immense variety of types and variations under the types that occur in nature, as well as the great irregularity or departure from ideal forms sketched by previous observers. The angles 60° are preserved everywhere, but the combinations of parts are innumerable. Hellmann notices many peculiarities in the crystals from a crystallographer's point of view. With regard to the structure of the crystal, he finds as the most remarkable point the fact that the principal and subordinate rays are hollow capillary tubes. This fact had been known hitherto in only one special form of snow crystal, but the microphotograph shows that it exists everywhere. After the publication of a notice of Hellmann's work, other works were published confirming this structure, such as that of G. Nordenskiold, in Stockholm, published by the geological society in that city, and he also recognizes it in the careful drawings published by Rossetti in 1681. Hellmann finds that the purely star-formed snow crystals on the average are larger than those that have the shape of 6-sided plates, in the ratio of 2.8 to 1.9, as deduced from his early observations, and in the ratio of 2.3 to 1.3 from the micro-photographs. As regards the connection with temperature, Scoresby showed that crystals were more delicate and thinner and, in general, smaller as the cold increased. Hellmann finds that at —10° C. they are but one-third the size of those at —2° C. The microphotographs show the following mean diameters as the average of 6 to 10 cases: 3.4 milimeters at —6° C.; 2.2 mm. at —8° C.; 1.2 mm. at —12° C. He notes that the diminution in the weight of aqueous vapor per cubic meter in saturated air proceeds in very much the same ratio, viz: 3.2 grams for —6° C.; 2.7 grams at —8° C.; 2.0 grams at —12° C., and —0.5 grams at —30° C. The number of cases of occurrence of the different types of crystals also depends upon temperature, but the connection is not yet at all certainly made out; nevertheless the prevailing types occur in the following relative frequencies:

Relative frequency of snow crystals.

Forms of crystals.	Temperature.	
	—6° to —7.5°	—9° to —12.5°
	Per cent.	*Per cent.*
1. Stars with rays	52	24
2. Stars with flat expansions	22	19
3. Flat plates	26	57

From this we may conclude that the frequency of the flat forms increases, and that of the stellate forms diminishes with diminishing temperature, while the intermediate form, 2, occurs with equal frequency.

Hellmann finds the following classification adapted to his own observations. Type 1, lamellar snow crystals subdivided into (a) stars with rays; (b) flat plates, and (c) combinations of (a) and (b). Type 2, columnar snow crystals subdivided into (a) prisms; (b) pyramids and (c) combinations of (a) and (b). The type 1 is that usually observed both in temperate and polar regions.

Soon after the publication of Hellmann's work, in 1893, he discovered that not only Nordenskiold, at Stockholm, but also A. A. Sigson in Rybinsk, Russia, had been making microphotographs, some of which Hellmann reproduces in the Meteorologische Zeitschrift, 1894, p. 281, as these were the largest and most perfect yet attained. If to these three European collections we add the still larger collection made by W. A. Bentley during the years 1870–1895, it would seem that we have material for a very complete study of the forms and methods of formation of the snow crystal. But at present there does not seem to be much prospect of deriving from this study any additional knowledge of the temperature, moisture, and pressure prevailing when they are formed. It seems to the Editor much more likely that the small amounts of other gases and vapors occasionally present in the atmosphere, or the nature of the nucleii around which the crystals form, or the transitions through which they pass as they recrystalize while descending to the earth, may have a greater influence on their forms than pressure, moisture, and temperature.

BOMBARDING HAIL CLOUDS.

In answer to numerous inquiries about shooting at hail clouds for the purpose of dispersing them, the Editor would state that although statistics show that during the past year 15,000 shooting stations were established in Italy and a very large number in southern France and Austria, yet there is no evidence whatever that the shooting done by these stations has had any effect whatever upon the hailstorms or the hail. Generally the quantity of powder used is so small that the vortex rings are not able to ascend farther upward than 1,000 feet. They do not, therefore, reach the clouds; and if any effect could be produced upon the hail, it could only be by virtue of the noise or the dust, and these are far less than those made by Dyrenforth in his experiments with dynamite in 1892. The very sensible report of the director of the agricultural societies of the southeast of France says:

> We cannot conclude that the use of cannon will always afford complete protection, but it is undeniable that the results obtained are very interesting.

The recent congress of hail-shooters at Padua (25–29th November, 1900), could only conclude that we are in the midst of an extensive experiment, and that several years' work will be required in order to ascertain the true effect of the cannonading.

In some parts of France for several centuries it has been the custom to ring the church bells when a hailstorm is approaching. The modern newspaper writer guesses that the people do this by reason of their belief in the efficacy of the sound of the bell; but the historical fact is that this was originally simply an invitation to all good churchmen to unite in prayer for deliverance.

There is no doubt that the cannonading is believed to be effectual by the farmers who do the work; otherwise, they would hardly continue the labor and expense; and yet we must remember that waves of irrational enthusiasm sometimes sweep over a community only to be regretted in subsequent years, when a calmer judgment has come to prevail. The fact that 10,000 or 20,000 shooting stations have been established is of itself no argument as to the efficacy of the process. One might as well argue that the moon really affects the weather because a million people believe it, and can prove it—to their own satisfaction. A knowledge of the exact truth on any question of natural science is not easily attained, else the world would long since have progressed far beyond its present status in knowledge and civilization. The

most common errors among mankind are those that are based upon fallacies in reasoning rather than errors in observation. Thus, in the present case, we have innumerable reports to the effect that "a black cloud was seen approaching, cannon were fired, and the cloud passed over without hail," or "it passed to one side and the hail did not fall on the protected vineyard," or "it advanced to the edge of the vineyard and there the hail ceased" or "the cloud broke in two, passing to the right and the left, leaving the sky cloudless over the cannon." Now all these are quite common cloud and storm phenomena; they will happen oftentimes without any cannonading. The best friends of the Stiger or Italian method of annihilating hailstorms have recently confessed that the method is still in its infancy or experimental stage and that it is still necessary to investigate and demonstrate its value.

It is not yet time to say with an American writer—

> The cannonading does seem to have some effect in the way of changing hail to rain, and though the exact measure of that effect is still a matter of dispute, chiefly among those who, like the scientific paper mentioned, do more theorizing than observing, yet the owners of the vineyards are convinced that the protection secured is worth much more than it costs.

As to theorizing, those who are best acquainted with the true scientific man know that he is wholly devoted to observed facts, to the recognized laws of nature, and to arguments that are as logical as mathematics. It is the popular writers who are so apt to disseminate ideas that have no scientific basis.

METEOROLOGY AS A COLLEGE COURSE.

In previous numbers of the MONTHLY WEATHER REVIEW we have stated rather fully the recent work of members of the Weather Bureau in the matter of instruction in meteorology, either collegiate or otherwise. It will be interesting to review the early activity of our colleagues in this matter. Thus we understand that in 1887–88, at Northfield, Vt., Prof. H. J. Cox inaugurated a course of meteorology as a member of the faculty of the Norwich University.

In 1885 the president of the Columbian University invited the Editor to establish a course of instruction in meteorology and climatology in the Corcoran scientific school of that institution. In 1877 the board of directors of the Cincinnati University invited Mr. S. S. Bassler, then in charge of the station in that city, to give instruction in meteorology as a part of the regular course of the university. Preparations for this work were completed when Mr. Bassler was transferred to Chicago, Ill., in November, 1877, and the project fell through.

The Editor would be glad to receive short statements of the early services of other men in this special field of college work. If those residing in university or college towns would look up the history of the respective institutions and send us short notes as to the instruction given in our science, usually as a part of the duties of some professor of astronomy, chemistry, geology, or physics, these would constitute interesting contributions to the history of the part taken by American colleges in the development of this science. It is quite common to forget what was done a hundred years ago, but most of us probably know that Prof. Elias Loomis taught this subject quite thoroughly from the beginning of his career at Yale College, 1833; then in the Western Reserve College, at Hudson, Ohio, 1837–1844; again at New York University, 1844–1859, and finally at Yale University from 1860 to 1889.

In former times this subject was usually taught in connection with some other science; thus Prof. Robert Hare, the chemist, wrote and lectured on meteorology in the University of Pennsylvania, 1818–1847. Prof. Joseph Lovering, the physicist, included this in his lectures at Harvard University. His present successor, Prof. John Trowbridge, has also interested himself in vortex motions, atmospheric electricity, and other meteorological problems, but the special teaching of meteorology is left to Prof. R. deC. Ward. Professor Olmstead, at Yale, and now Professor Brewer, at the same institution, also Professor Renwick, at Columbia, have taught meteorology as a part of the courses in physics and chemistry. Professors Chamberlin, at Chicago, and Tarr, at Cornell, include it in geology and physical geography. Nearly all the professors of natural philosophy have given it some attention ever since the days of Newton and Cotes at Cambridge, England, but natural philosophy is now generally broken up into special courses of physics (which is sometimes subdivided into mechanics, optics, acoustics, and electricity), chemistry, geology, meteorology, etc. At the University of Michigan, Prof. M. W. Harrington gave special courses of lectures on climatology for several years before he was appointed Chief of the Weather Bureau. We do not seem as yet to have anything in America quite equivalent to the eminent professorships of meteorology held by Kämtz, at Dorpat, Schmid, at Jena, von Bezold, at Berlin, and Hann, at Vienna.

MARS AND THE EARTH.

On December 16 Professor Pickering, of the Harvard College Astronomical Observatory, received from his assistant at the Lowell Observatory at Flagstaff, in Arizona, a telegram saying that a shaft of light had been seen to project from the planet Mars, lasting seventy minutes. Whenever anything remarkable is observed in the heavens the facts are at once telegraphed to all interested astronomers in order that they may concentrate attention upon the subject, and add as much as possible to our knowledge before the fleeting phenomenon has vanished. This was done in the present case, telegrams being sent to astronomers in both Europe and America. The Lowell observatory gives especial attention to the planet Mars, and has already published a magnificent volume showing the apparent changes that occasionally occur.

This simple announcement of an observed fact has come back to America as a news item scarcely recognizable, viz, that Professor Pickering has been in communication with the planet Mars. This story has brought out from Tesla the statement that he also has observed on his telegraph wires electrical oscillations that may have come from Mars or some other planet, though he does not give us any data by which to judge of the rationality of this conclusion. Following him, Mr. William A. Eddy, of New York, announces that ever since 1890, or whenever he flew his kites by means of metal wire, he was liable to receive electric currents that must have come from some planetary region, or possibly, the sun, or the upper atmosphere.

Following upon these newspaper paragraphs an occasional correspondent inquires, first, as to their authenticity, and next as to their relation with meteorology.

We think we have said enough to show that the original observation published by Professor Pickering is reliable. We believe the other observations by Tesla and Eddy are probably explicable as the result of the ordinary irregularities in terrestrial magnetism, and do not necessarily place us in connection with planetary bodies. Finally, we agree with our colleague, Mr. Talman (and others who have written on the subject for a century past), as to the extreme improbability of there being any one alive on any of the planets with whom we could have intelligent exchange of ideas, even if optical or electrical signals could be sent and received.

Recent studies by means of liquid air have shown that the earth's atmosphere is undoubtedly constantly giving to and taking from interplanetary space a little of the more vol-